

The Trends in Environmental Regulations in China

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Problems with environmental pollution are emerging along with the rapid economic growth in China, and measures to protect the environment are becoming increasingly important. The 11th Chinese Five-Year Environmental Protection Plan (2006-2010) set total emission regulation targets for pollutants, and China achieved those goals within that period. The 12th Chinese Five-Year Environmental Protection Plan (2011-2015) contains even more environmental regulations, including environmental measures in various fields, such as air quality, water quality, soil quality, and solid waste. A Chinese national strategy has also been created to help the environmental industry evolve over the long term. This paper will mainly cover new environmental regulations in China since 2011. In the near future, environmental regulations and environmental preservation technologies and know-how that have been used in developed countries will probably be useful in the environmental protection field in China.

Introduction

Since 1978, the People's Republic of China has had a population of approximately 1 billion people, and has had a large amount of economic growth in the short period of 30 years. Today, as the "world's factory", China is facing a myriad of serious problems with environmental pollution, which have come along with industrialization and urbanization, and the world is paying attention to the environmental measures that China enacts. China's Five-Year Environmental Protection Plan is China's most important environmental guideline, and has set some main targets for the environmental protection field. To achieve these targets, the Chinese government has created and revised many national environmental standards since the 1970s. These environmental standards establish specific environmental regulatory values and regulatory values for pollutant emissions. The 12th Chinese Five-Year Environmental Protection Plan is currently being implemented. This paper will discuss many related environmental regulatory trends in China, focusing on major environmental regulations for air pollution in detail.

State of the Environment & Environmental Measures in China

State of the Environment in China

During the 30 years of reforms since 1978, China has achieved a high level of economic growth. In particular, during the 10 years between 2002 and 2011,

China's gross domestic product (GDP) per capita has gone from a little over \$1,000 USD to \$5,432 USD, total GDP has gone from sixth in the world to second in the world, China is first in the world with over \$3 trillion USD in foreign currency reserves, and its annual average GDP growth rate is 10.7%^[1].

Currently, China's main industrial structure focuses on the heavy chemical industry, and this structure mainly depends on energy supplied from coal. As China's economy has grown, its consumption of energy and resources has increased. As a result, various types of economic pollution have progressed at the same time as growth, such as air pollution, water pollution, soil pollution, and destruction of ecosystems. The economic growth has given rise to the social phenomena of rapid urbanization, industrialization, the spread of automobiles, and economic disparity between regions. In particular, awareness about environmental protection is insufficient in medium- to small-sized cities and rural areas, and problems such as insufficient infrastructure for drinking water, sewage treatment, and waste processing facilities have emerged. It is also clear that the infrastructure that supports the environmental protection measures, such as funding, technology, personnel, regulations, and management, is insufficient. China has sustained rapid economic growth, and doesn't have sufficient time to work on environmental problems like developed countries did. Currently, in many regions in China, total pollutant emissions exceed nature's cleaning capacity, and a wide range of environmental pollution problems have become serious.

In recent years, air pollution has become a serious problem. As one example, as of January 29, 2013, the area of air pollution due to particulate matter nationwide in China reached 1.43 million km² (14.9% of the total). High concentrations of fine particulate matter (PM_{2.5})^[1] were observed in the cities of Beijing and Tianjin and in a wide range of provinces, such as Hebei, Henan, Shandong, Jiangsu, Anhui, Hubei, and Hunan Provinces, and these high concentrations (daily averages >75 µg/Nm³) continued for days. On the same date in Beijing, the daily average for PM_{2.5} was 354 µg/Nm³, an extremely high value^[2]. During the period of January through March of this year, in 74 cities throughout China, the air pollution standards were only met for 44.4% of the days, and the main pollutants were PM_{2.5} and PM₁₀^[3]. Figure 1 shows an example of Beijing's air pollution conditions in May 2013.



Air quality conditions: 2011

Air quality conditions: May 5, 2013

Figure 1 Beijing's air pollution conditions (Photo taken by author)

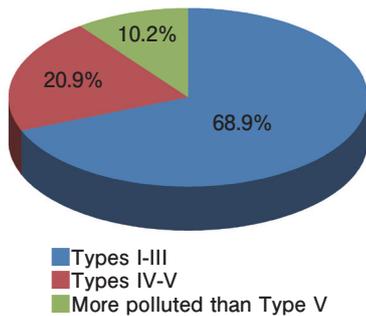


Figure 2 2012 State of water quality in 10 important river basins in China^{5 [4]}

There are also many issues with water quality. Figure 2 shows the 2012 water quality conditions in the 10 major river basins in China, namely the Yangtze River, Yellow River, Pearl River, Huai River, Liao River, Hai River, Songhua River, rivers in Zhejiang/Fujian Provinces, various southwestern rivers, and various inland rivers. The main polluting factors in the above rivers are Chemical Oxygen Demand (COD)^{*3} and Biochemical Oxygen Demand (BOD)^{*4 [4]}. With regard to ground water pollution, in some regions in the north China plains, the concentration of heavy metals (Pd, Cr, Cd, Hg, As, etc.) in the ground water exceeds the values in environmental standards, and organic pollution is also serious^[5]. In particular, in regions where the ground water is used as a source of drinking water, situations have resulted where people cannot drink the water. The main cause of this pollution is the discharge of unprocessed or insufficiently processed industrial waste water.

- *1: PM_{2.5}: Fine particulate matter with a diameter less than 2.5 μm.
- *2: PM₁₀: Coarse particulate matter with a diameter less than 2.5-10 μm.
- *3: COD: Chemical Oxygen Demand
- *4: BOD: Biochemical Oxygen Demand
- *5: Categories specified by the Chinese Environmental Quality Standard for Surface Water for the function of bodies of water:
 - Type I: Mainly applies to water in river heads/headstreams and nationally protected natural areas
 - Type II: Mainly applies to areas such as concentrated sources of drinking water in Class I protected areas, valuable protected fish areas, and spawning grounds for fish and shrimp
 - Type III: Mainly applies to concentrated sources of drinking water in Class II protected areas, general protected fish areas, and swimming areas
 - Type IV: Mainly applies to general industrial water areas and recreational water areas where humans do not come in direct contact with the water
 - Type V: Mainly applies to agricultural water areas and bodies of water necessary for general scenery
 - More polluted than Type V: Bodies of water that are even more polluted than Type V

Table 1 The main measures, Targets and Actual numbers for the 11th Five-Year Plan

Substance	Target (Compared to 2005 emissions)	Measure	Actual (Compared to 2005 emissions)
COD	Reduce by 10%	Spread of sewage treatment 52% (2005) →72% (2010)	Reduced by 14.29%
SO ₂	Reduce by 10%	Spread of desulfurization equipment 12% (2005) →82.6% (2010)	Reduced by 12.45%



Figure 3 Start of the Chinese air quality monitoring system for major cities (Photo taken by author)

Environmental measures in China through 2010

In 1973, China's first environmental standard, the Standard for Industrial Discharge of the Three Wastes⁶ was enacted, and in 1979 the Environmental Protection Law established China's first environmental field. This made the legal positioning of environmental standards clear. Protecting the environment is a basic national policy of China, and many environmental measures have been enacted to this point. Out of those, the most effective one was the period of time during the 11th

Five-Year Plan (2006-2010). That plan had 70% more environmental budget than the 10th Five-Year Plan. That plan set a total emission regulatory target of reducing the major pollutants COD and SO₂ by 10% compared to 2005, and a target of reducing energy consumption per unit of GDP by approximately 20%. To achieve these targets, the government has actively worked to establish infrastructure and equipment to prevent pollution. The average concentration of SO₂ in the air in major cities in China has been reduced by 26.3% compared to 2005^[6]. Table 1 shows the main measures, targets, and actual numbers for the 11th Five-Year Plan. The National Phase III Automotive Exhaust Gas Standard has been implemented nationwide in China, and the National Phase

IV Automotive Exhaust Gas Standard has been moved up for major cities, due to the 2008 Beijing Olympics and 2010 Shanghai World Expo.

In November 2010, to make society aware of the results of ambient air pollution monitoring, Minister Zhou Shengxian and Vice-Minister Wu Xiaoqing Ministry of Environmental Protection of the people’s Republic of China launched the Air Quality Monitoring System for major cities. This system publishes real-time air quality monitoring data (hourly average for 3 components: SO₂, NO₂, and PM₁₀ from 600 measurement bureaus) for 113 major cities on the Internet. Figure 3 shows the launch ceremony for the system. In addition, as of January 1, 2013, monitoring data for 6 components (SO₂, NO₂, PM₁₀, O₃, CO, PM_{2.5}) are now being published for 74 cities in the Air Quality Monitoring System.

China achieved the targets in its 11th Five-Year Environmental Protection Plan, but many environmental pollution problems in China remain unsolved, and environmental conditions are still difficult.

*6: The three wastes: Drain water, emission gas, and solid waste.

Latest trends in Chinese Environmental Regulations

Overview of 12th Chinese Five-Year Environmental Protection Plan and related plans

Key targets from the 12th Chinese Five-Year Environmental Protection Plan (in progress since 2011) are shown below.

- 1) Reduce total pollutant emissions
- 2) Improve water quality by assuring the environmental safety of drinking water sources
- 3) Control pollution by heavy metals
- 4) Prevent pollution from Persistent Organic Pollutants (POPs)⁷, hazardous chemicals, hazardous waste, etc.
- 5) Build environmental infrastructure and equipment in cities, towns, and regions, and improve technology for the maintenance and management of the infrastructure/equipment
- 6) Improve the tendency for ecosystem environments to decline
- 7) Increase the capability for monitoring and managing nuclear power and radioactive safety, and improve the level of safety for handling nuclear power and radioactive substances

8) The 12th Five Year Environmental Protection Plan for Strengthening Environmental Monitoring and Management Structures set 7 specific targets. Table 2 shows the total pollutant emission regulations and targets for improving the environment.

Compared to the 11th Five-Year Plan, the 12th Chinese Five-Year

Table 2 Quantitative targets for the 12th Chinese five-year environmental protection plan^[7]

Field	Pollutants	2010	2015	Change
Emissions from pollution sources	Total COD emissions (Thousands of tons)	25,517	23,476	-8%
	Total NH ₃ -N emissions (Thousands of tons)	2,644	2,380	-10%
	Total SO ₂ emissions (Thousands of tons)	22,678	20,864	-8%
	Total NO _x emissions (Thousands of tons)	22,736	20,462	-10%
Environment	Surface Water Monitoring site (National Infrastructure site)'s percentage of water quality categorized as more polluted than Type V ⁵ (%)	17.7%	<15%	-2.7
	National Infrastructure Bureau's percentage of water quality in 7 river basins categorized as better than Type III (%)	55%	>60%	5
	Percentage of air quality better than Class II in regional class or higher cities (%)	72%	≥80%	8

Table 3 Main plans related to environmental protection in China

Name	Ministries and government agencies in charge (China)
12th Five-Year Plan for Preventing Air Pollution in Major Regions	Ministry of Environmental Protection
12th Five-Year Plan for Preventing Pollution by Heavy Metals	Ministry of Environmental Protection
12th Five-Year Plan for Preventing Water Pollution in Important River Basin Areas	Ministry of Environmental Protection National Development and Reform Commission Ministry of Finance Ministry of Water Resources
12th Five-Year Plan for Treating Waste Water in Cities Nationwide and Building Facilities for Reclaiming Water	State Council
12th Five-Year Plan for Building Facilities for Detoxifying Trash in Cities Nationwide	State Council
12th Five-Year Plan for Nuclear Safety and Preventing Radioactive Contamination	Ministry of Environmental Protection (National Nuclear Safety Administration) National Development and Reform Commission Ministry of Finance National Energy Administration State Administration for Science, Technology and Industry for National Defense

Environmental Protection Plan has set many quantitative targets that China is obligated to achieve. To achieve the above targets, China must set and implement environmental regulatory values and work on stricter environmental measures. This 12th Five-Year Plan emphasizes things such as liquidating low-efficiency production equipment and factories, reducing total energy consumption, promoting the use of green energy, and adjusting and controlling the number of automobiles in a city. The Chinese government forces to adopt the achievement of the targets for total pollutant emissions to evaluate regional

industry development. The regulations also mandate that local governments and important industries, such as the paper manufacturing, dye, chemical, electrical power, iron and steel, and cement industries, set total regulatory targets, and require that NO_x emissions from automobiles and ships be controlled. In addition to the 12th Chinese Five-Year Environmental Protection Plan, many other plans have been released relating to environmental preservation, such as the 12th Five-Year Plan for Preventing Air Pollution in Major Regions. Table 3 shows the main plans.

Here, we will use the 12th Five-Year Plan for Preventing Air Pollution in Major Regions as a specific example. This plan set targets to reduce the annual average concentrations of PM₁₀, SO₂, NO₂, PM_{2.5} in the air by 10%, 10%, 7%, and 5% respectively, in 117 cities in 13 major regions, such as Beijing, Tianjin, Hebei Province, the Yangtze River delta, and the Pearl River delta^[8], and strengthens regional air quality monitoring and management. This was the first plan in China that works to prevent total air pollution, and attempts to improve air quality by stipulating environmental improvement targets based on air total pollutant emission regulations. The Chinese Ministry of Environmental Protection and related central government ministries and agencies also established many five-year plans, such as the 12th Five-Year

National Strategic Plan for Developing New Industries, and are supporting the promotion of environmental industries from various sides. Table 4 shows the main 12th Five-Year Plans.

Table 4 Main 12th five-year plans related to the Chinese environmental industry and Chinese ministries /government agencies in charge

12th Five-Year National Strategic Plan for Developing New Industries	State Council
12th Five-Year Plan for Conserving Energy and Environmental Industry	State Council
12th Five-Year Plan for Developing the Environmental Service Industry	Ministry of Environmental Protection
12th Five-Year Plan for Developing Environmental Equipment	Ministry of Industry and Information Ministry of Finance
12th Five-Year Plan for Remodeling and Building Water Supply Facilities in Chinese Cities	Ministry of Housing and Urban-Rural Development National Development and Reform Commission

*7: POPs: Persistent organic pollutants.

Standards for Chinese environmental regulations

In China, some environmental standards set specific numbers for environmental regulations. During the

approximately 30 years until the end of 2010, 1,494 environmental standards were established, and currently 1,312 have been implemented. As such, China's structure for environmental standards has basically been prepared^[7]. Most of these standards (53.7%) are for environmental monitoring, which is a major category. The standard values for pollutant emissions in China differ by the type of industry, so there is a very large number of standards for specific industries. Also, many standards for pollution emissions from mobile sources have been established. The categories of standards and number of standards are shown in Table 5.

The above environmental standards have been released, and the main standards that are directly related to environmental regulations are mainly standards regarding environmental quality and standards for pollutant emissions. The main standards are shown in Table 6.

*8: GB: Guo Jia Biao Zhun
(Abbreviation in Chinese national standard romanization system)

Chinese environmental standards are divided into national government standards and local government standards. Some local governments use their own local government environmental regulations that are stricter than the national government regulations, while other local governments are doing the same criteria as the national government standard with earlier implementation dates.

Table 5 Chinese environmental standards being implemented^[7]

Chinese environmental standards	Number
Environmental quality standards	14
Standards on pollutant emissions	138
Environmental monitoring standards	705
Management regulations	437
Basic standards	18
Total	1,312

Table 6 Main environmental quality standards and pollutant emission standards

Standard category	Standard name	Number
Environmental quality standards	Ambient Air Quality Standard	GB 3095-2012 ^{*8}
	Environmental Quality Standard for Surface Water	GB 3838-2002
	Quality Standard for Ground Water	GB/T 14848-93
Pollutant discharge standards	Emission Standard of Air Pollutants for Thermal Power Plants	GB 13223-2011
	Standard of Air Pollutants for Iron Smelting Industry	GB 28663-2012
	Emission Standard of Pollutants for Coking Chemical Industry	GB 16171-2012
	Standards of Pollutants from Rare Earth Industry	GB 26451-2011
	Integrated Wastewater Discharge Standard	GB 8978-1996
	Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants	GB 18918-2002
	Discharge Standard of Water Pollutants for Iron and Steel Industry	GB 13456-2012
Limits and Measurement Methods for Exhaust Pollutants from Motorcycles and Mopeds Under Two-Speed Idle Conditions	GB 14621-2011	

Chinese environmental standards 2011 onward

Central government ministries and agencies including Ministry of Environmental Protection of the people's Republic of China established 73 new and revised environmental standards in 2011, and 68 in 2012. These are closely related to the targets in the 12th Chinese Five-Year Environmental Protection Plan.

Environmental standards

In recent years, improving air quality has been raised as an important target. Many environmental standards regulating air pollutant emissions have been established in a short time. In 2012, the Ambient Air Quality Standard (applies starting on January 1, 2016) was released, which adds PM_{2.5}, O₃, CO to the existing regulated air pollutants (SO₂, NO₂, PM₁₀). At the present time, there are two classes of regulatory values for PM_{2.5}^[9]. Table 7 shows the PM_{2.5} regulatory values. The Ambient Air Quality Index (AQI) Technology (Trial) (HJ¹⁰ 633-2012) was established as a method for evaluating air quality. Previously, an air pollution index (API)¹¹ (3 components: SO₂, NO₂, PM₁₀) was used to evaluate air quality, but a decision was made to change to using

Table 7 PM_{2.5} Regulatory values^[9] in the Chinese ambient air quality standard and Japanese regulations

Country	Annual average (µg/m ³)	Daily average (µg/m ³)
China	Class 1 <15 (Class 2 <35)	Class 1 <35 (Class 2 <75)
Japan	<15	<35

an air quality index (AQI) (6 components: SO₂, NO₂, PM₁₀, PM_{2.5}, O₃, CO). The Method for Measuring the Weight of PM₁₀ and PM_{2.5} in the Ambient Air was established as the standard method for measuring PM₁₀ and PM_{2.5} in the air. In 2012, the China Environmental Monitoring Center and local government environmental monitoring centers used this as the standard method for evaluating devices that continuously measure PM_{2.5}.

*9: AQI: Abbreviation for Air Quality Index

*10: HJ: Huan Jing Bao Hu Biao Zhun (Abbreviation in Chinese romanization system for environmental protection standards)

*11: API: Abbreviation for Air Pollution Index

Pollutant emission regulations

Recently, industries with large total NO_x air pollutant emissions were the first to establish standards for air pollutant emission regulations in particular. Thermal power plants are the industry that has the highest NO_x emissions, and this industry put out the Emission Standard of Air Pollutants for Thermal Power Plants in 2011. This standard is applied to boilers for generating power that produce at least 65 tons/hour of steam. Emission regulatory values and implementation schedules have been set for existing thermal power plants, as well as additional equipment and new power plants. For example, the following regulations have been established for NO_x emissions:

- 1) As of January 1, 2012, the NO_x regulatory value for exhaust gas from new coal thermal power plant boilers is 100 mg/Nm³.
- 2) Starting on July 1, 2014, the NO_x regulatory value for flue gas from all thermal power plant boilers in major regions will be 100 mg/Nm³. The regulatory value for boilers in non-major regions that began operation before the end of 2003 is 200 mg/Nm³.
- 3) Starting on January 1, 2015, the emission regulatory value for mercury and mercury compounds will be 0.03 mg/Nm³ [11].

Before it was revised, the Emission Standard of Air Pollutants for Thermal Power Plants listed the SO₂ emission regulatory value for major regions as 200 mg/Nm³ [12]. If the sulfur content of the coal is low, and the desulfurization efficiency of desulfurization equipment in thermal power plants is at least 95%, the majority of boilers for coal thermal power plants can achieve values at or below the SO₂ emission regulatory value. During the period of 2006-2010, many units of desulfurization equipment (such as the wet lime-gypsum type) were installed, which have a low capital investment cost. The Emission Standard of Air Pollutants for Thermal Power Plants took effect on January 1, 2012, which set the SO₂ emission regulatory value in major regions to a strict 50 mg/Nm³ [11]. It is difficult to quickly change the coal for power generation to coal with a low percent of sulfur, so higher-efficiency desulfurization equipment was required.

More and more things are being required of the environmental industry to achieve the new targets. It is likely that thermal power plants will remodel old desulfurization equipment and buy new equipment, and invest in equipment such as instruments that continuously measure the pollutants such as SO₂ and NO_x from flue gas that come out of the desulfurization equipment in low concentrations. Of course, local government environmental protection bureaus will also be required to have portable monitoring instruments and methods for

inspecting flue gas continuous monitoring data.

After the thermal power plant environmental regulations were established, to strengthen air pollutant emission regulations in major industries, 8 environmental standards were established in 2012 for the iron and steel industries and coal chemical industry. Some examples are the Standard of Air Pollutants for the Iron Smelting Industry and the Emission Standard of Pollutants for the Coking Chemical Industry, and these have stricter regulatory values for air pollutants such as dust, SO₂, and NO_x than the existing regulations. In addition, in November 2012, the Chinese Ministry of Environmental Protection of the people's Republic of China released public comments for the Emission Standard of Air Pollutants for Cement Industry. Up until now, the NO_x emission regulatory value had been 800 mg/Nm³, which decreased to 450 mg/Nm³ for existing equipment and 320 mg/Nm³ for new equipment^[13]. The emission regulations for pollutants such as dust and SO₂ also became stricter.

Standards for measurement technology are essential for monitoring reductions in air pollutant emissions from stationary sources. In 2011, to increase the reliability of monitoring data, the Standard for Technology for Measuring SO₂ Flue Gas from Stationary Pollution Sources Using the Non-Dispersive Infrared (NDIR) Method (New) and the Quality Management Technology Guidelines for Environmental Measurements (New) were established. Also in 2011, the Limits and Measurement Methods for Exhaust Pollutants from Motorcycles and Mopeds Under Two-Speed Idle Conditions (Revised) was established for air pollutant emissions from mobile sources. In 2012, official government documents such as the Government Opinion on the Process of Controlling PM_{2.5} by Strengthening Measures to Prevent Automotive Pollution were released, which strengthened the inspections for new and used vehicles across the board^[14]. The sulfur content of automotive fuel is seen as being a problem and one of the causes of PM_{2.5} pollution in large cities in China. In 2011, regulations on the quality of automotive fuel were strengthened, and the introduction of desulfurization equipment for automotive fuel is expected to improve fuel quality in China in the future.

Future developments

According to the report entitled China 2030 by the World Bank and the Development Research Center of the Chinese State Council, China's GDP will exceed that of the United States by 2030. The report also says that going green to transform environmental stresses into green development as a driver for growth will be required for China to move from a medium-income country to a high-income country (GDP per capita of \$16,000 USD)^[15]. President Xi Jinping and Prime Minister Li Keqiang took power in China in March 2013, and they are taking measures to emphasize environmental preservation. When Chairman Xi Jinping took office recently, he expressed an intention not to sacrifice the environment for temporary economic growth^[16]. Over the next 10 years, the Xi Jinping-Li Keqiang regime will probably emphasize environmental measures. A national strategy has been decided in which industries that conserve energy and environmental protection will be strengthened as strategic new national industries, and that an annual average growth rate of at least 20% will be maintained between 2011 and 2020. The

load on the natural environment in cities will increase over the next 20 years due to population increases in Chinese cities, and it is becoming increasingly important to coordinate and strengthen environmental regulations. Environmental regulations and measures are being implemented to improve environmental conditions, and the Chinese environmental industry is expected to have stable growth over the next 20 years. Over the past 10 years, about 4 trillion Chinese yuan (approximately 60 trillion Japanese yen) was spent in China for environmental preservation measures, but these were not effective enough. One reason is that the efficiency of environmental protection businesses was not high. For China to improve the efficiency of its environmental businesses in the future, it is important that China actively utilize the successful experiences of developed countries by using their environmental regulations and environmental protection technologies. The valuable experience gained by developed countries is a world asset, and will surely lead to better environmental protection in China, East Asia, and the world.

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